CHAPTER 7

MLRS COMMUNICATIONS

One of the six basic tasks of the field artillery battalion is to communicate. The ability of MLRS units to provide fires depends on a responsive, dependable communications sytem. The MLRS units must be prepared to rely on voice and/or data radio communications, usually over long distances, with many diverse and highly mobile units.

Requirements

A communications system must satisfy one or more of the following requirements, but it may not necessarily satisfy them all:

- **Reliability** is the ability to function with the desired accuracy and dependability at all times. Elements of a reliable system are robustness, resiliency, and a sufficient capacity to meet all communications requirements.
- **Flexibility** is the ability to support widely dispersed forces under adverse conditions. Some indicators of a flexible system are multimeans, multiaxis (more than one line or net), mobility (to move with the supported force), and modular construction for ease of repair and replacement.
- **Security** is the ability to protect messages from unauthorized exposure and usage. Also, security is protection to the user from exposure to electronic warfare.
- **Speed** of the system must be sufficient to ensure timeliness of the message.
- **Economy** ensures timely communications with a minimum amount of personnel and equipment.

When planning communications systems, consider both internal and external requirements to communicate:

- **Internal** communications requirements include the facilities for control and coordination of the activities of the unit. The installation and maintenance of internal communications systems are the responsibility of the unit commander. In a higher headquarters, such as a battalion or division, the internal communications system serves as part of the external communications system of the subordinate unit.
- **External** communications requirements include the facilities by which a unit maintains communication with its next higher headquarters, adjacent units (as required), and supported or reinforced units. These allow the unit to receive data and information necessary to do its mission. The commander of any unit is responsible for the integration of his communications assets into the communications system of the next higher headquarters.

Means

Communications systems differ according to the various means of communication--messenger, visual, sound, radio, and wire.

The communications means in a unit depend on the personnel, equipment, and transportation provided by the MTOE. The various means of communication have different capabilities and limitations. The means employed in any situation are generally those that provide the reliability, flexibility, security, and speed that meet or exceed the minimum required by the situation. Means should be employed so that they complement each other to provide the flexibility needed for communicating. Reliable communication can be greatly increased by using all the means available.

Messenger System

Messenger systems are the most flexible, reliable, and secure of the communications systems. There is no formal messenger service at the corps or division level. When messenger service is required, the signal office is responsible for determining routes and schedules. The G3 is responsible for tasking the units for vehicles and personnel. Below division level internal courier systems can be established with organic assets.

Visual and Sound Systems

Visual and sound systems have similar advantages and disadvantages. They are used extensively in almost all

situations and are readily available to everyone. They must be preplanned and coordinated to ensure comprehension. Advantages include a limited electronic signature in creating either visual or sound signals. They do not emit radio frequency (RF) signals, so EW is not a threat. Disadvantages are the noise, confusion, dust, and smoke of the battle, which can obscure many of the signals. Also, enemy forces can mimic and deceive by the use of similar signals. Signal operation instructions include a section that lists some visual and sound signals. SOPs list the remainder for a specific unit operation.

Radio System

Radio has advantages when compared to the other means. It does not require a physical link; therefore, radio transmissions can span great distances very quickly. It is easily installed and requires a minimum of manpower to operate. When required, it can be remoted away from operations centers, retransmitted to achieve even greater distances, and combined with wire systems as a result of net radio interface (NRI) to allow commanders to communicate over wire and radio. Another advantage - the ability to scramble our transmissions - while providing security, may lead to a disadvantage. When conversations cannot be overheard, operators tend to talk too long and too often, which can make the unit susceptible to enemy electronic warfare. Radio direction finding can target the transmitter; and interference, jamming, and intrusion can render radio communication relatively useless. Radio is also susceptible to co-site interference (antennas located too close to one another); mutual interference (bleed-over caused by radios operating on adjacent frequencies); and electronic noise created by placing antennas near power lines, generators, and other emitters such as radar and microwave sites.

Wire System

Wire also has advantages when compared to the other means. It is more secure than radio, visual, and sound systems; but it is never to be considered completely secure without cryptographic devices. Wire systems are not particularly vulnerable to EW, but they are extremely susceptible to damage from enemy artillery and our own tracked vehicles. Because of its limited vulnerability to EW, wire is almost always the system of choice in a defensive operation. It is also valuable in offensive operations when the situation and time permit its installation. Surprise may be obtained by using a wire system in preference to radio to prevent giving away positions. While wire systems have some distinct advantages over radio, they also have offsetting disadvantages. They are not mobile, with the exception of the mobile stations in the MSE system. They must be carefully planned before installation. Their installation requires more time, personnel, and equipment than the other systems. While they are mostly secure, they can be tapped. Not all taps require a physical connection to the wire.

Responsibilities

General responsibilities for communication are discussed below.

Echelons of Command

The senior unit is responsible for establishing communication with its subordinate units, whether organic or attached. This responsibility is primarily one of planning and directing the establishment of the linking communications systems, since assets belonging to either the senior headquarters or the subordinate unit may be used (senior-to-subordinate relationship).

Tactical Missions

Each of the four standard tactical missions has an inherent communications responsibility. (See Chapter 3.)

Battle Area

Adjacent commands must maintain communication with each other to ensure coordination of the combat effort. The command on the left establishes communication with the command on its right as facing the forward edge of the battle area (FEBA) or FLOT (left-to-right relationship).

Joint Maintenance

Regardless of which unit is responsible for establishing communication, all units served by the system must help restore any communications system disruption.

Staff Responsibilities

Individual responsibilities for the communications system are discussed below.

Commander

The commander is responsible for the adequacy and proper use of the communications system within his command. He is also responsible for its efficient operation in the system of the next higher command. The authority to establish, maintain, control, and coordinate the various communications means within the command may

be exercised by a subordinate in the name of the commander when such authority is properly delegated.

Battalion S3

The S3 establishes priorities for communication in support of tactical operations. In coordination with the battalion signal officer, the S3 selects the general locations of the command posts and affiliated installations with communication as a major consideration. The rest of the staff submits requirements to the S3 for signal communication.

Battalion S2

The S2 assesses the enemy's capability to interfere with signal communication. He is also responsible for the counterintelligence aspects of signal operations within the battalion.

Battalion Signal Officer

The BSO works under the staff supervision of the S3 but is directly responsible to the commander for the battalion communications systems. The BSO advises the commander and staff on electronic counter-countermeasures (ECCM), signals security, communications training, communications planning, and selection of CP sites from a communications standpoint. He prepares the command and signal paragraph of the FA support plan. He coordinates with signal units for communications support. He supervises the communications activities in the battalion, to include the installation, operation, and maintenance of the battalion communications system and equipment. He is responsible for the COMSEC equipment and serves as the battalion COMSEC custodian for the unit. He issues and accounts for COMSEC equipment, key lists, codes, ciphers, SOI, and authentication systems.

Planning Considerations

Plans

The communications plan is designed to fulfill the requirements of a tactical mission. Planners use communications responsibilities, communications requirements, and the unit TOE (which provides the communications means) to produce a standardized system. To meet specific requirements, commanders may have to modify their systems on the basis of METT-T.

Standard Radio Nets. The field artillery uses a set of standard radio nets for all of the standard tactical missions. This net standardization enables units to quickly and accurately interface in a combat environment. Standard net structures and purposes should not be arbitrarily changed except to tailor them to a modified mission. Such modifications should be kept to a minimum. Standard net structures (net titles, purposes, users, and equipment) are defined in this manual. They should be applied in unit SOP and kept current as changes occur.

Voice and Data Nets. The radio net architecture should change, depending on whether the unit has predominantly voice or data communication. MLRS battalions operate in nine internal voice nets (four for command and control, four for logistics coordination; and one for voice fire direction) and four internal FM data nets (three battery and one battalion fire direction). Additionally, the battalion operates on one internal Amplitude Modulated Very High Frequency (AM-VHF) for long range communications (voice or data). The battalion also operates on six external nets: two FM data, one FM C^2, one FM ops/intel, one FM logistics, and one AM-SSB for Corps Arty Cmd or ops/fire. This architecture is designed to support a system that relies primarily on data communication. If data capability is lost by the battalion or by one or more of the batteries, the voice nets quickly become overburdened. Units must develop plans for converting some data nets to voice while continuing to support the remaining digital stations and for reconverting to data nets as that capability is restored. It is extremely important to keep voice traffic off data nets and vice versa, so a specific sequence for conversion must be developed for various contingencies. This procedure should be included in unit SOP and practiced during training.

System Mixes. The factors of METT-T affect the use of wire, visual, sound, and messenger systems to a greater extent than they do the radio nets. Any system or mixture of systems that will communicate the information with the least exposure to enemy EW and not place total reliance on radio is preferred. To describe any one system as "primary" is no longer appropriate.

Electronic Counter-Countermeasures. ECCM should be part of each battalion SOP. They can improve OPSEC and preserve communications. ECCM techniques that have been found to be effective include the following:

- Require authentication on nonsecure nets. Proper authentication procedures can eliminate intrusion and imitative deception.
- Do not mix plain and encrypted traffic on the same net. Doing so compromises the nature of the net,

which makes interception and analysis easier for the enemy.

- Use secure equipment whenever possible. If the battalion is supporting a unit without secure capability, specify nets that will be unsecured and enforce secure discipline on all remaining nets.
- Limit transmissions to less than five seconds. This makes interception and direction finding more difficult.
- Work through jamming if at all possible. Jumping nets should be a last resort. Remember that if jamming is bad enough to keep a unit from operating on a particular net, it will also keep many of the stations from receiving the signal to change frequencies. If antijam frequencies are to be used, they must be disseminated well in advance, so that subscriber stations can move to the alternate frequencies in sequence as communication becomes impossible on the primary frequency.
- Use only authorized call signs from the SOI, and change them on schedule.

Operations

Communications operations must take advantage of all available techniques to facilitate accomplishment of the mission. Techniques such as remoting transmitters, radio retransmission, antenna multiplexer, and the use of directional antennas help the MLRS battalion to provide timely fires and to survive to fight again.

Remote Transmitters. Remoting transmitters allows for the separation of the RF emitter from the personnel and equipment of the CP or other critical facilities. Also, remoting radios allows the transmitter to be sited for optimized communication while allowing the user to position in locations better suited to survivability. Remoting also minimizes on-site or mutual interference while dissipating and reducing electronic signatures. For additional information on remoting, see FM 24-18.

Retransmission. Retrans operations may be used to extend the area of coverage of a specific radio net or to reduce the electronic signature of a position. By use of a retrans site, RF power output can be reduced at the CP or other location. Overall net ranges can be doubled by the effective use of retransmission.

Frequency modulated very high frequency (VHF) transmission distances are restricted by terrain and obstacles. The siting of radio equipment is often critical. The following are helpful hints for using FM retransmission:

- As a minimum, make a map recon of the area of operation. Coordinate with the S2 and S3 during the planning phase.
- Analyze the terrain for optimum communications to support the scheme of maneuver.
- Select primary and alternate locations for retrans. Consider accessibility, defense, and logistical support.
- Arrange the timetable for site occupation and net operation. Don't wait until a retrans vehicle is needed before sending it out.
- Ensure operators are well trained. They must be able to provide manual relay if they have equipment failures.
- Ensure operators are aware of the tactical situation.
- Ensure users understand how retrans works.
- If retransmitting data traffic, program additional key and/or delay time to allow radios to key up.

Note: Additional information on retransmission operations is in FM 24-18.

Antenna Multiplexer. Using antenna multiplexer, such as the TD- 1288 or TD- 1289, reduces the number of ground plane antennas required to operate multiple radios. The time required to align and tune these devices is considerably less than the time required to install multiple antennas. More information on antenna multiplexer is in TM 11-5820-880-12.

Directional Antennas. Directional antennas reduce electronic signatures in two directions while extending the range of the radio along the long axis of the antenna. Techniques concerning antenna construction and siting are included in ECAC-CR-83-200.

Reestablishment. Communication is essential to providing fire support. If communication with a station is lost, everything possible must be done to reestablish the link. The operator should--

- Troubleshoot the radio.
- Erect omnidirectional or unidirectional antennas.

Data nets are backed up by voice nets and vice versa. If data communication is lost, resolve the problem on the voice net. Unit SOP must prescribe exact actions to be taken to reestablish communication, and all personnel must be intimately familiar with those actions.

Communications Planning Ranges

Table 7-1 below can be used in communications planning. The ranges presented here were determined under ideal conditions; weather and terrain may have drastic degrading influences.

Table 7-1. Communications Planning Ranges

SYSTEM	POWER OUTPUT	VOICE RANGE	DATA COMMUNICATIONS	
			BAUD RATE	RANGE
RT-841	4 W	8 km		
RT-524/ RT-246				
LO	8 W	8 km	600-2,400 bps	22 km
HI	35 W	40 km	4,800 bps	19 km
			16,000 bps	9 km
RT-1439/ RT-1523				
LO	500 μW	400 m		
M	160 mW	5 km		
HI	4 W	10 km		
PA	50 W	40 km	600-2,400 bps	25 km
			4,800 bps	22 km
			16,000 bps	10 km

Note: bps = bits per second; mW = milli watts; μW = micro watts; W = watts

Communications Tips

The following tips will help in establishing and operating a responsive and dependable communications system:

Do--

- Use the lowest power setting for effective transmission.
- Make transmissions as short as possible.
- Use proper radiotelephone procedures.
- Use the proper antenna (a directional antenna if possible).
- Use masking, if possible, to hide your signal.
- Use only authorized codes.
- Remote radios if possible.
- Enforce net discipline.
- Authenticate.
- Try to work through jamming.
- Plan for the use of retrans.
- Keep radios aligned and tuned.

Net Structures

MLRS Battalion

External Communications. The battalion operates on five external FM and one AM radio nets to communicate by voice and data with higher headquarters. Two of the FM nets are for data communication and three are for voice communication (see Figure 7-1, page 7-6).

- **Force FA Cmd Net (VHF-FM)(V).** This secure net is the primary voice (V) command and control link between higher headquarters and the MLRS battalion.
- **Force FA Ops/F Net (VHF-FM)(D).** This secure net provides the data link between the battalion FDS and the controlling headquarters TACFIRE.
- **Force FA Admin/Log Net (VHF-FM)(V).** The battalion operates on this net to coordinate external logistics requirements and support.
- **Corps Arty Cmd (AM/SSB)(V) and Ops/F Nets (AM/SSB)/(D).** These nets provide the battalion link to the corps headquarters. These nets share a single AM radio system. Its primary function is the corps arty cmd net. As required, the unit moves to the Ops/F net.
- **Force Ops/lntel (VHF-FM) (V).** This net provides the battalion operational and intelligence information regarding the current operations of the supported force.
- **Force FA Tgt Acq (VHF-FM) (D).** This net is used for data communication between the fire direction centers and attached target acquisition assets or sensor system down-links as part of TMD.

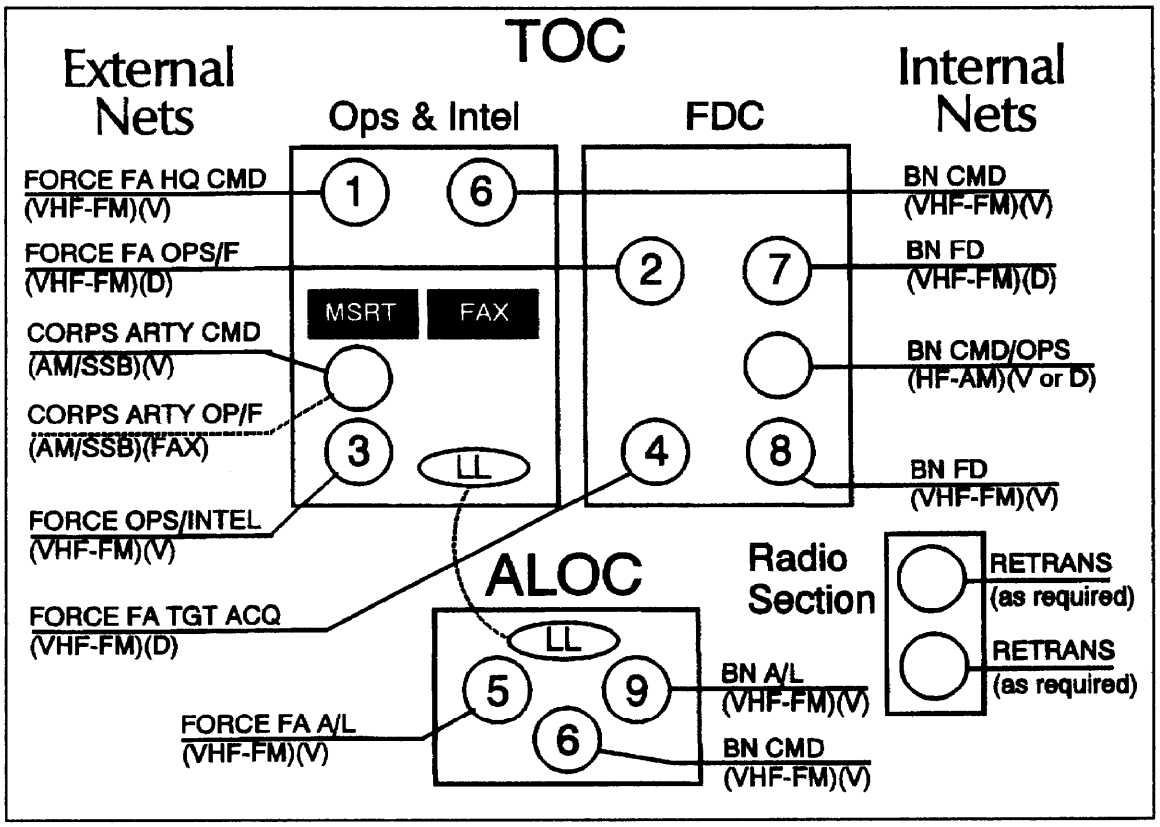

Figure 7-1. MLRS battalion net structure.

Internal Communications. The MLRS battalion communicates with the subordinate batteries mainly by secure FM voice and secure data means. Wire is used only within the HHS elements because of the position of the batteries and the limited quantity of wire. The battalion operates on four (4) internal FM radio nets (plus two nets dedicated to RETRANS) and one internal AM radio net to communicate with its firing batteries.

- **Battalion Cmd Net (VHF-FM)(V).** This secure net is the main voice crud and control net used by the commander, his staff, subordinate commanders, and BOCs and as an alternate FD net. The NCS is the battalion operations section.
- **Battalion Fire Direction-1 Net (VHF-FM)(D).** This secure net is used exclusively for data (D) communications between BOCs. No voice traffic should be used on this net. The NCS is the battalion FDC.
- **Battalion Fire Direction-2 Net (VHF-FM) (V).** This secure net is exclusively for voice communications between fire direction centers. It facilitates planning, rehearsals, and execution and prevents this traffic from interfering with C^2 functions and data transmissions on other nets. Although this particular net may not be authorized for a specifc unit in a given theater, it is imperative that these functions are allocated a net other than those allocated for C2 and data communications functions.
- **Battalion HF Cmd/Ops Net (HF-AM)(V or D).** This secure net facilitates secure long-range communications between the battalion FDC and the BOCs. This net uses an HF AM radio for voice or data communications with the batteries
- **Battalion Admin/Log Net (VHF-FM)(V).** This secure net is used to reduce the amount of traffic on the cmd net. The NCS is the ALOC.

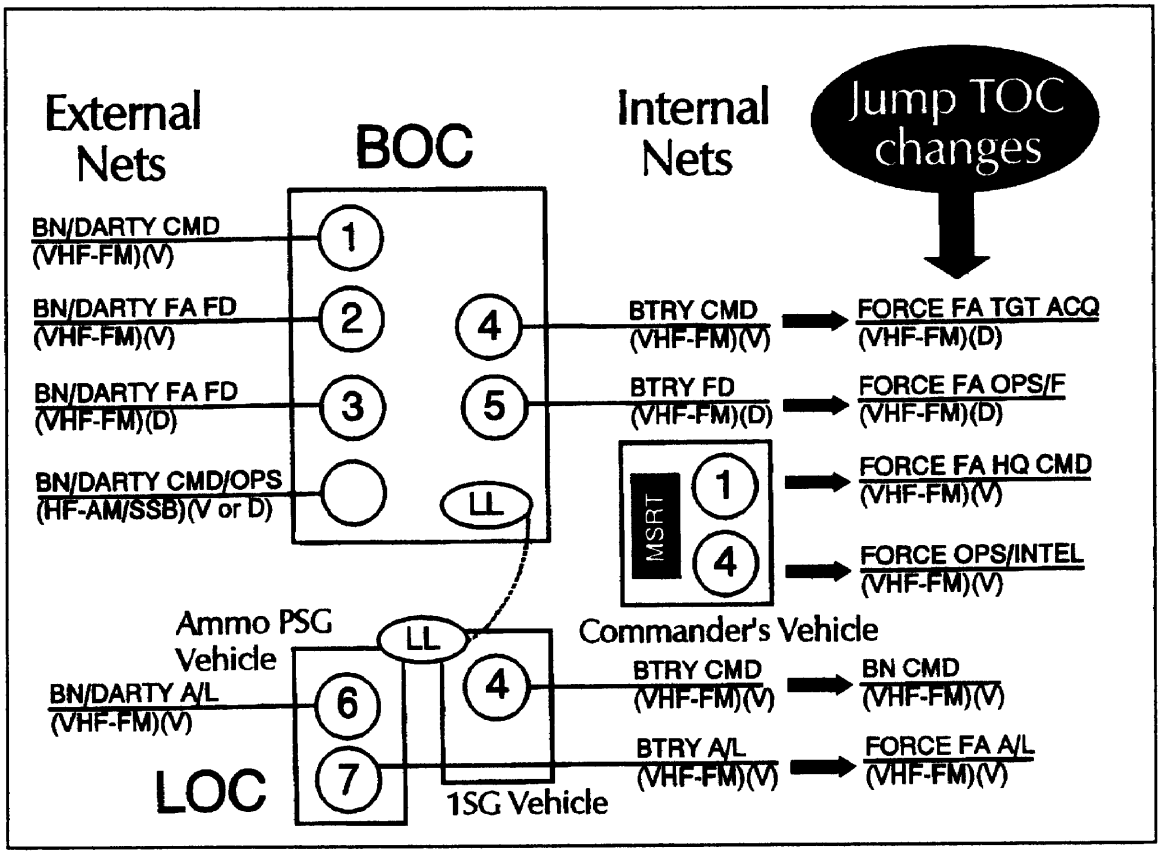

Figure 7-2. MLRS battery net structure.

MLRS Battery

External Communications. As the main unit of MLRS employment, the firing battery is designed to operate as part of an MLRS battalion or independently, under the force FA headquarters. The battery operates on four external FM radio nets and one AM radio net to communicate by voice and data with higher headquarters. In a standard GS or GSR mission, the battery would operate on the force FA headquarters and/or the reinforced unit on these nets. If the battery has a standard R mission, the BOC enters the reinforced unit cmd net and the FD net. If the battery is given a nonstandard R mission, the FDC may enter the FD net of the reinforced unit and establish FM voice communications specified in the fire support plan (see Figure 7-2).

- **Controlling FA Headquarters (for example, div arty or MLRS bn) Cmd Net (VHF-FM) (V).** This secure net is the main command and control link between higher headquarters and the MLRS battery.
- **Controlling FA Headquarters FD-1 Net (VHF-FM) (D).** This secure net provides the data fire direction link between higher headquarters and the MLRS battery.
- **Controlling FA Headquarters FD-2 Net (VHF-FM) (V).** This secure net is exclusively for voice communications between fire direction centers. It facilitates planning, rehearsals, and execution and prevents this traffic from interfering with C^2 functions and data transmissions on other nets.
- **Controlling FA Headquarters Admin/Log Net (VHF-FM) (V).** This secure net is optional and is used to reduce the amount of traffic on the battalion net. It keeps administrative and logistical traffic from interfering with command and control transmission.
- **Controlling FA Headquarters Cmd/Ops Net (HF-AM/SSB) (V or D).** The battery can communicate by voice or data via an AM HF radio. This ability facilitates longer range communications with the controlling FA headquarters.

Internal Communications. The MLRS battery has three internal FM radio nets. Although the battery has no capability to lay external wire, internal wire lines can link elements within a position. However, communications usually are achieved through voice or data FM radio, rather than wire. The BOC is the NCS of both the battery and and battery FD nets. The LOC is the NCS of the A/L net.

- **Battery Cmd Net (VHF-FM)(V).** This secure net gives the battery commander his main voice communications and control link to his platoons. Each firing section monitors this net during normal operations. The firing sections may use it for voice-transmitted fire missions if data communications with the FDS are lost. Net discipline is essential. Short, mission-essential radio transmissions enhance survivability.
- **Battery FD Net (VHF-FM)(D).** This secure net is used only for fire mission processing and other data communications between the battery BOCs, POC, and launchers.
- **Battery Admin/Log Net (VHF-FM)(V).** This secure net is used to reduce the amount of traffic on the battery cmd net. It keeps administrative and logistical traffic, such as ammunition, recovery, and maintenance support, from interfering with command and control transmissions. All HEMTTs/HEMATs, maintenance, supply, and recovery vehicles operate on this net.

MLRS Platoon

Communications at platoon level are limited to FM (voice and data) radio. Each platoon headquarters has four secure FM radios in the armored CP carrier. They are used for the battery cmd net the **battery FD** data net, the **battalion FD** voice net, and the **Battery Admin/Log** net. If operating as a jump BOC, the platoon HQ can operate on all required nets except the HF-AM/SSB **CMD/OPS** net. An example of jump BOC radio configuration is at Figure 7-3.

Figures 7-3, page 7-9 and 7-4, page 7-10 are MLRS communications matrices.

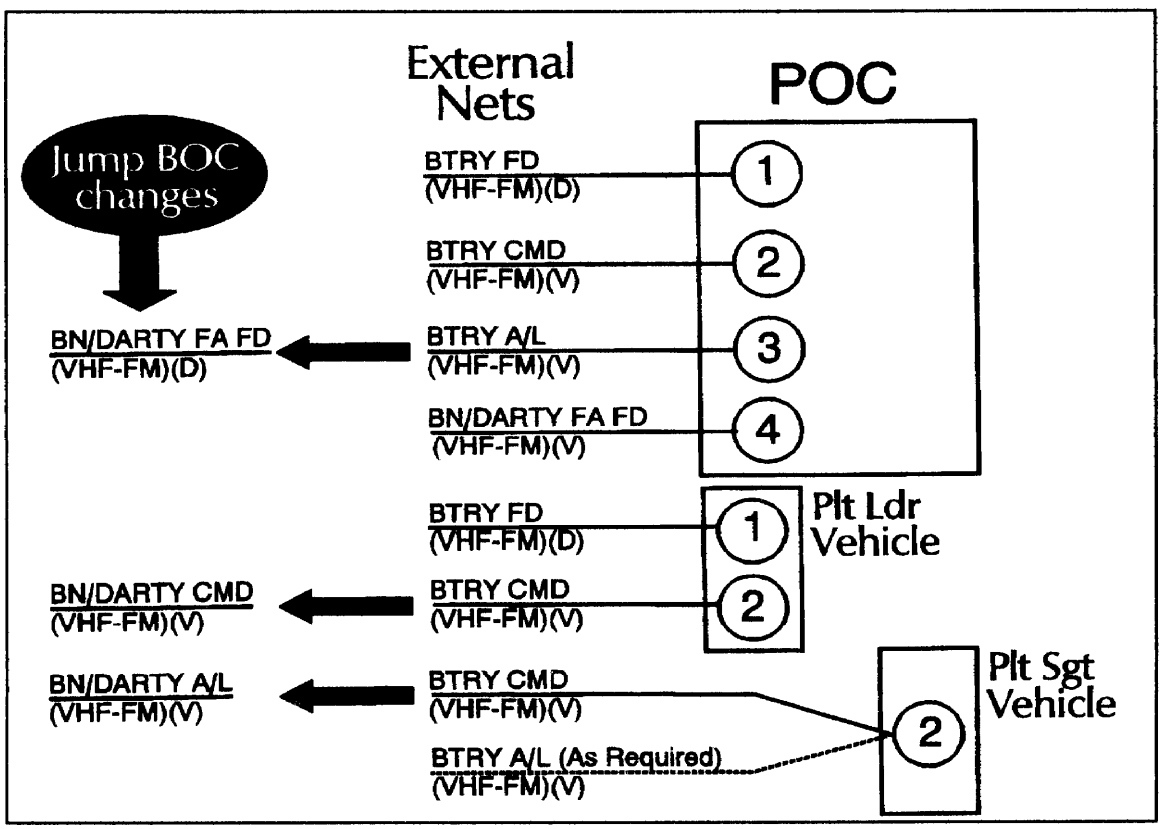

Figure 7-3. MLRS platoon net structure.

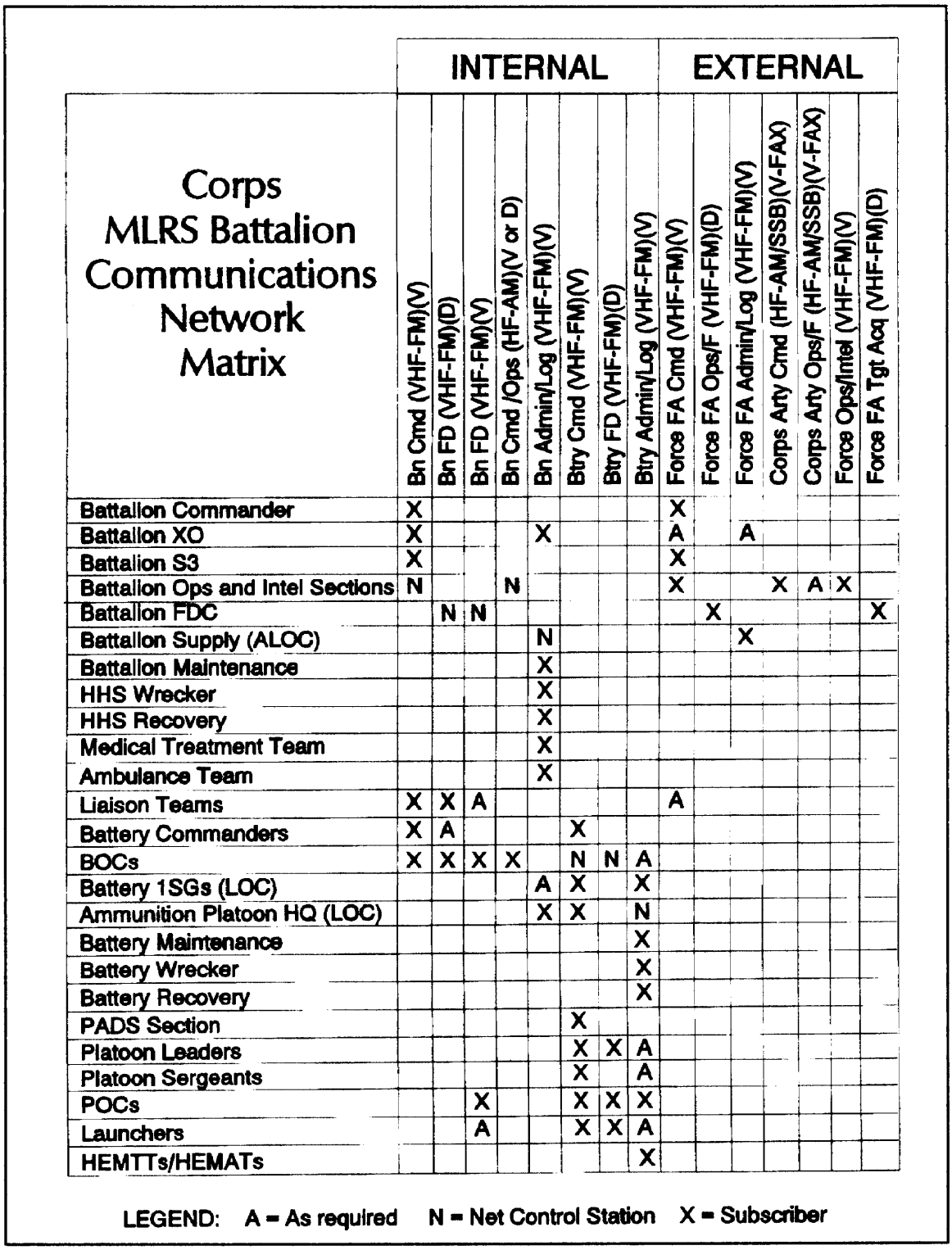

Figure 7-4. Corps MLRS battalion communications network matrix.

Divisional MLRS Battery Communications Network Matrix

	EXTERNAL					INTERNAL		
	Bn/Divarty Cmd (VHF-FM)(V)	Bn/Divarty FD (VHF-FM)(D)	Bn/Divarty FD (VHF-FM)(V)	Bn/Divarty Cmd /Ops (HF-AM)(	Bn/Divarty Admin/Log (VHF	Btry Cmd (VHF-FM)(V)	Btry FD (VHF-FM)(D)	Btry Admin/Log (VHF-FM)(V)
Battery Commander	X	A				X		
BOC	X	X	X	X		N	N	A
Battery 1SG (LOC)					A	X		A
Ammunition Platoon HQ (LOC)					X			N
Battery Maintenance								X
Battery Wrecker								X
Battery Recovery								X
PADS Section						X		
Platoon Leaders						X	X	A
Platoon Sergeants						X		A
POCs			X			X	X	X
Launchers			A			X	X	A
HEMTTs/HEMATs								X

LEGEND: A = As required N = Net Control Station X = Subscriber

Figure 7-5. Divisional MLRS battery communications network matrix.

Each launcher has two secure FM radios. The launcher crew operates on both the **battery cmd** net and the **battery FD** net through the launcher FCS. The crew can communicate with the platoon headquarters and the BOC. The platoon leader and the platoon sergeant each have two secure FM radios mounted in their HMMWVs. The platoon leader normally operates on the **battery cmd** net and the **battery FD** net through the FED. The platoon sergeant normally operates on the **battery cmd** or the **Battery Admin/Log** net as required.

Mobile Subscriber Equipment

The MSE system provides secured voice, data, and fax communications to the user, whether static or mobile. It is an area communications system extended by mobile telephone. The MSE can be used for data transmissions, however, its main purposes are for voice telephone and fax communications.

The division and corps signal units will establish the MSE system by positioning signal nodes throughout the division and corps area of operations. Small extension nodes (SENs) will be placed near maneuver brigade and div arty CPs and throughout the rear areas. The MLRS battalions access the MSE system either by wiring into the extension nodes or by using cellular-type radiotelephones through the signal nodes.

When in place, the MSE network works similar to a civilian telephone system. Subscribers are assigned individual telephone numbers, which can be dialed directly. Text and graphics can be transmitted in hard copy via the fax capability of the system (see Figure 7-6). The MLRS battalion uses three key pieces of equipment when it operates in the MSE system. These are discussed below.

Digital Nonsecure Voice Telephone (DNVT) TA-1035/U or TA-1042A/U

The DNVT is the conventional telephone of the MSE system. It must be wired into the J-1077/U junction box, which is located at the area signal node. The user is responsible for laying wire to the junction box. The MLRS battalion will have DNVTs in the CP, TOC, ALOC, with the chaplin, and at the firing batteries. The DNVTs cannot operate with the older wire telephones, such as the TA-312.

Mobile Subscriber Radiotelephone Terminal (MSRT) AN/VRC-97

The MSRT is the mobile cellular telephone of the MSE network. It links into the MSE system through one of the remote access units (RAUs) positioned throughout the area of operations by the signal unit. The RAU picks up the signal from the MSRT and switches it into the nearest signal node. The MLRS battalion has seven MSRTs. They are mounted in the vehicles of the battalion commander, XO, S3, S4, and each firing battery commander. The battalion also has two stand-alone installation kits (SAIKs), which allow the battalion S3 MSRT to be dismounted for use in the TOC and the S4 MSRT to be dismounted for use in the ALOC.

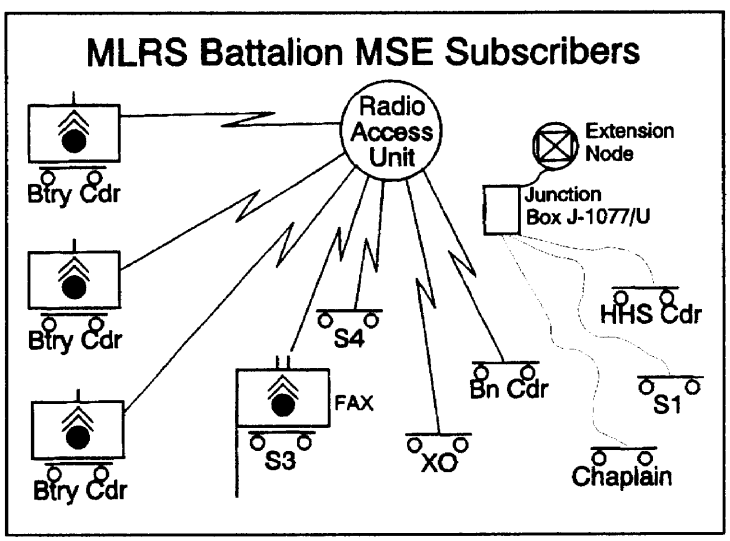

Figure 7-6. MSE subscribers.

Lightweight Digital Facsimile (LDF) AN/UXC-7 or AN/UXC-7A

The LDF, when connected to the MSE system through the DNVT or DSVT, allows the battalion to send and receive text and graphics in hard copy. It can also be connected to the FM radios.

Single Channel Ground and Airborne Radio System

General

The AN/VRC-12 Series radios are being replaced by the SINCGARS family of radios. (See Table 7-2 below.)

Table 7-2. SINCGARS Radios

SINCGARS SYSTEM[2]	QTY R/T[1]	BACK PACK	PWR AMP
PRC-119[2]	1	0	0
AN/VRC-87	1	0	0
AN/VRC-88	1	1	0
AN/VRC-89	2	0	1
AN/VRC-90	1	0	1
AN/VRC-91	2	1	1
AN/VRC-92	2	0	2

Notes: [1] RT-1439 W/O COMSEC
RT-1523 W/Imbedded COMSEC
[2] Systems using RT-1523 are identified with an additional "A" identifier (e.g., AN/VRC-92A)

The user of a SINCGARS radio must physically change the frequency. However frequencies can be stored which makes changing them (physically) much easier. The SINCGARS radio is more complicated to operate than the old VRC-12 series and requires more sustainment training for the operators to maintain proficiency. See FM 11-32 for defaulted information on SINCGARS.

Data Communications

The MLRS FDS is limited to a data rate of 1200 bits per second (bps) and audio frequency shift keying (AFSK or FSK). For FDDMs, Version 10 software allows the operator to select data rates of 1200, 2400, 4800, 9600, or 16,000 bps on channel 5.

FSK is an analog method of transmitting data as a pair of tones: a 1200 Hz tone representing a "1" and a 2400 Hz tone representing a "0" (1300 and 2100 Hz tones are also used to be compatible with KY-57 crypto equipment). The modem in each TACFIRE device converts the data 0s and 1s to these tones which are then transmitted just as voice is over the radio. SINCGARS is a data radio system. It converts analog voice (as well as analog and data) to a binary data signal (a series of 1s and 0s) at 16,000 bits per second(bps) for transmission and converts the data signal back to an analog voice (or analog or data) signal upon reception. The SINCGARS uses a data rate adaptor (DRA) to handle data signals. When the DRA is fed data at a rate less than 16 Kbps, it uses the difference in time to send each bit (0 or 1) several times (e.g., at 1200 bps each bit is transmitted 13 times in the 16 Kbps signal). The receiving SINCGARS then uses a primitive form of error correction known as majority logic to determine the identity of the bits and convert the data back to the original data rate. With older radios (AN/VRC-12 generation), when the signal gets weak or distorted, known as a low signal to noise ratio (S/N ratio), the receiver simply amplifies the noise and the weak signal. A low S/N ratio with SINCGARS causes the bits to be lost or distorted. With analog voice transmissions, a large bit error rate (BER) can be tolerated (i.e., one bit in ten can be lost or confused and the signal can still be understood by the radio operator since the human ear is very forgiving). In data communications between computers, the BER must be less than one error in 1000. This is why it is possible to have good voice communications with SINCGARS and not be able to establish data communications. The following considerations will improve data communications using SINCGARS:

- Try to maintain a good radio line of sight (LOS) using higher antennas, and watching for intervening crests. Shorter ranges improve S/N ratio and lower the BER.
- Don't remote data nets unless essential for antenna siting. Because data transmissions are very short, they are hard for the enemy to detect using RDF.
- Use single channel mode. Frequency hop (FH) reduces range and reliability of data communications (max data rate for FH is 4800 bps).
- Use the best antenna available. A good antenna ground plan system improves output power. Directional antennas are also more efficient thus decreasing the S/N ratio and BER.
- If selectable, lower the data rate.

- Isolate and shield radio equipment from all other electronic or power generation equipment that may radiate energy and reduce the S/N ratio by increasing the noise level.
- Use lower frequencies to cut propagation path loss.

Antennas

Poor communications or lack of communications can be caused by long distances between transmitter and receiver, unfavorable terrain, and other conditions. This problem can often be overcome by the use of the right antenna. When the tactical situation allows, the battalion FDC, the battery BOCs, and the POCs should use an extended-range antenna the OE-254/GRC, or the OE-303/GRC to obtain the maximum planning range of their radios.

To obtain the maximum efficiency of an antenna, the following factors must be considered:

- An antenna site should not be located in or near obstacles such as tunnels, overpasses, or steel bridges. They can block or reflect signals.
- Trees with heavy foliage and dense underbrush should be avoided as they can absorb signals.
- Antennas should not be set up near pole wire lines and high-tension power lines. They can introduce interference and absorb part of the radio signals. This also constitutes a safety hazard.